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LEAN MANUFACTURING IMPLEMENTATION USING VALUE STREAM MAPPING TO ELIMINATE SEVEN WASTE IN PAINTING PROCESS

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ABSTRACT

Gas stove producers faced intense competition in the market. This condition encourages gas stove producers to increase productivity by reducing 7 (seven) waste in the production process, especially in painting process. The purpose of this study is to determine the factors that can affect the reduction of 7 (seven) waste in the production process, knowing the number of Value Added (VA) and Non Value Added (NVA) in the reduction of 7 (seven) waste. The method used to identify waste is the Value Stream Mapping, for analysis of repairs used 5W 1H tools. VSM can provide a description of the material flow, and information during the production process, starting from the arrival of raw materials from suppliers to the delivery of finished products. From the calculation, a decrease in lead time by 1098.3 seconds and a decrease in NVA of 332.3 seconds were obtained.

KEYWORDS: Lean, Value Stream Mapping, Waste, 5W1H, VA & NVA

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INTRODUCTION

At present, the gas stove industry is facing intense competition. Competition is not only between domestic products, but also with imported products. The very thin difference in prices between products also affects the tight competition. For gas stove products, competition includes one stove model, two furnaces and three furnaces. To face competition in the gas stove market, producers are trying to improve product competitiveness. Increasing competitiveness is done with product pricing and quality strategies. Competition also encourages gas stove producers to increase productivity by reducing 7 (seven) waste in the production process. The objectives to be achieved in this study are to find out the factors that can affect the reduction of 7 (seven) waste in the production process.

Common problems faced by stove producers are quality and performance. Problems related to quality such as dented and scratched stove body, ignition lighter, thin paint and uneven paint. The problems related to performance such as red fire, and low efficiency. Furthermore, in improving product quality, companies must set clear and specific goals based on input from consumers. In general, consumers want high quality products and are available on the market. Therefore, all available resources in the company can be directed at improving product quality and increasing production volumes. The quality improvement program is run by the company using one of Lean Manufacturing tools, Value Stream Mapping.

The objectives to be achieved in this study are to find out the factors that can affect the reduction of 7 (seven) waste in the panting process, and knowing the number ofLead Time and Non Value Added (NVA) in the reduction of 7 (seven) waste.

STUDI LITERATURE

Lean Manufacturing

Haider et al. (2007) explained that Lean Manufacturing was developed by Toyota Japan and is now widely practiced by many producers in the world. Lean manufacturing is a system for identifying and reducing waste through continuous improvement. Lean Manufacturing is carried out by flowing products in attracting customers in pursuit of perfection. Lean manufacturing is important, especially due to waste reduction and decreased lead time. Tokola et al. (2016) explain that Lean Manufacturing philosophy includes several methods that aim to eliminate waste. Erfan(2010) describe that elimination of waste is the target of each system. This concept is very important in a very competitive world there is currently nothing we can waste.

The philosophy of tools Lean Manufacturing is to provide products with minimal costs, on time as requested by customers, use an effective waste disposal process to maximize product value and also ensure product quality according to customer needs and desires. Lean Manufacturing tools make production systems more flexible, which in turn, can be the right long-term strategy for sustainable competitive advantage. Flexible business is the ability of the organization to respond appropriately to the changing needs and desires of consumers, which are endlessly extraordinary in the global world (Tiwari & Tiwari, 2016). Rosenbaum et al.(2012) found that in the production process, there are problems related to determining the amount of labor needed. This is related to internal work decisions or sub-contracts. In addition, there are difficulties in inventory management at several warehouse points.

In addition to 7 (seven) waste, there is waste related to the environment, one of which is waste of energy. For example is a machine that lights up without producing a product, so that there is excessive waste of electricity and heat (Bashkite & Karaulova, 2012). Lopes et al. (2015) find that the past few years have shown an increase in the use of Lean Manufacturing principles and equipment in several industrial sectors. Already an established management philosophy, it has shown many successful applications even outside the production environment. Manzouri,et al (2014) found that many techniques and equipment are important for reducing costs and waste and providing effective services for customer needs.

The application of lean manufacturing has been proposed in almost every domain of life. In manufacturing, it is common that lean manufacturing is not only suitable for mass production (A. Haider & Mirza, 2015). Toyota claims that lean manufacturing has been described as a philosophy that seeks to eliminate waste by aligning processes in a sustainable flow, and using resources to solve problems in a continuous process. Waste is a human activity that absorbs resources but does not create customer defined values. So, waste in this context is the misuse of resources and / or the possibility of the company (Reyes et al., 2018). Puvanasvaran et al.(2010) proves that Lean Manufacturing helps organizations develop manufacturing and administrative management solutions and make the organization leaner and at the same time, achieve world class standards in terms of production, quality and marketing

Parthipan, J, & Nirmalkannan, (2015) found that Lean Manufacturing is a method based on the philosophy of continuous improvement and a method that is tailored to analyze and influence productivity. The change in layout, from batch to single stream, effectively reduces the queue. Lean Manufacturing is a principle that focuses on reducing costs by identifying and eliminating non-value-added activities. A very global and competitive market from the demands of the 21st century increase product variations that are high in reducing costs, reducing lead times and perfect quality. This changed scenario requires new manufacturing methods that will enable them to compete in this competitive globalization market Neha et al.(2013).

Value Stream Mapping

VSM is one of the key tools for implementing lean manufacturing to identify opportunities for variations in lean manufacturing tools. Because VSM covers all stages of the process, both VA and NVA, VSM is used to identify waste and waste sources (Rahani & Al-Ashraf, 2012). Manufacturing companies are faced with challenges regarding the cost effectiveness, lead time and quality of the production system. Therefore, it is necessary to integrate the inspection process with the process chain, which is needed to ensure the quality of production. One of the tools needed for process chain configuration is VSM. To integrate the inspection process in the process chain an innovative approach is called Quality VSM (QVSM). QVSM can facilitate the identification of the effectiveness of test equipment, testing strategies, and Quality Control circles (Benjamin, 2014).

VSM can be integrated with other tools, such as AHP. VSM implementation followed up with a single piece flow can reduce NVA, increasing response to customer demand. Therefore, the company's targets regarding quality, cost and delivery can be fulfilled(Venkataramanet al., 2014). VSM can be integrated with Kaizen to increase maximum efficiency (Fitri Ikatrinasari & Kosasih, 2018). Pandya et al.(2017) found that Lean Manufacturing promises to increase productivity by reducing several parameters such as Lead Time, Inventory, production costs, and material use. The study also mentions that VSM is an approach that proves to be suitable in complex work environment conditions. VSM can distinguish between value-added and non-value-added activities. On the other hand, products are produced simultaneously in different lines of work. VSM analyzes the flow of one unit of production in all value streams(Rosenbaum et al., 2012).

METHODOLOGY

This study describes the conditions of the production process, starting from the arrival of material, planning the production schedule, the production process to the delivery to the customer. This study use primary and secondary data. Primary data in this study were obtained by direct observation on the production line. Primary data includes production process time, idle time and delay time calculated using a stop watch. Secondary data in this study were obtained from the Engineering Division, Purchasing Division and the monthly report of the Quality Control (QC) division. Secondary data from the Engineering Division is a production flow process, while secondary data from the QC division includes reject data and rework in each work station.

Primary data collection in this study is by observation on the production line or observation. The observation carried out in this study was to observe part of the production process of one stove gas stove, namely the painting process. The observations were carried out at the factory location. Observation is carried out in normal shift working hours. Secondary data collection in this study is to use documentation. In this study, the population is all gas stoves for households, the sample studied was a single burner gas stove for households. This sample was chosen because, this stove is the most produced in factory.

The stages of VSM preparation in this study are determination of product used as a model, then make Current State Map, determine VA and NVA and develop Future State Map. Map is made for each process category or work station. Information on each work station is visualized in the data box. The data box contains information on Cycle Time, Change over Time, Uptime, number of operators, work time and type of raw material.

RESULTS

Current State Map

Stages to make Current State Map are identifying Cycle Time. The Cycle Time data are shown on table below.

Table 1: Cycle Time

Process	Cycle Time (Seconds)
Degreasing	602.2
Rinsing 1	120.2
Surfacing	120.1
Phosphating	901.3
Rinsing 2	121.9
Oven	900.7
Painting	31.9
Curing	901.4

After calculating Cycle Time, next step calculating of Change over Time. Change over Time data are shown at table below

Table 2: Change Over Time

Process	Change Over Time (Seconds)
Degreasing	0
Rinsing 1	0
Surfacing	0
Phosphate	0
Rinsing 2	0
Oven	205
Painting	0
Curing	185

Next step, uptime calculation is done with the formula = 100% - (C/O time / CT). Uptime data are shown at table below.

Table 3: Uptime

Process	Uptime (Seconds)
Degreasing	100%
Rinsing 1	100%
Surfacing	100%
Phosphating	100%
Rinsing 2	100%
Oven	77.3%
Painting	100%
Curing	79.5%

After identify time waste, next step is identify inventory waste or Work in Process (WIP). WIP data are shown at table below.

Table 4: Work in Process (WIP)

Process	WIP
Degreasing	100%
Rinsing 1	100%
Surfacing	100%
Phosphating	100%
Rinsing 2	100%

Table 4: Contd.,	
Oven	77.3%
Painting	100%
Curing	79.5%

After identifying time waste and inventory waste, the current state mapping can be arranged as figure.1 follow:

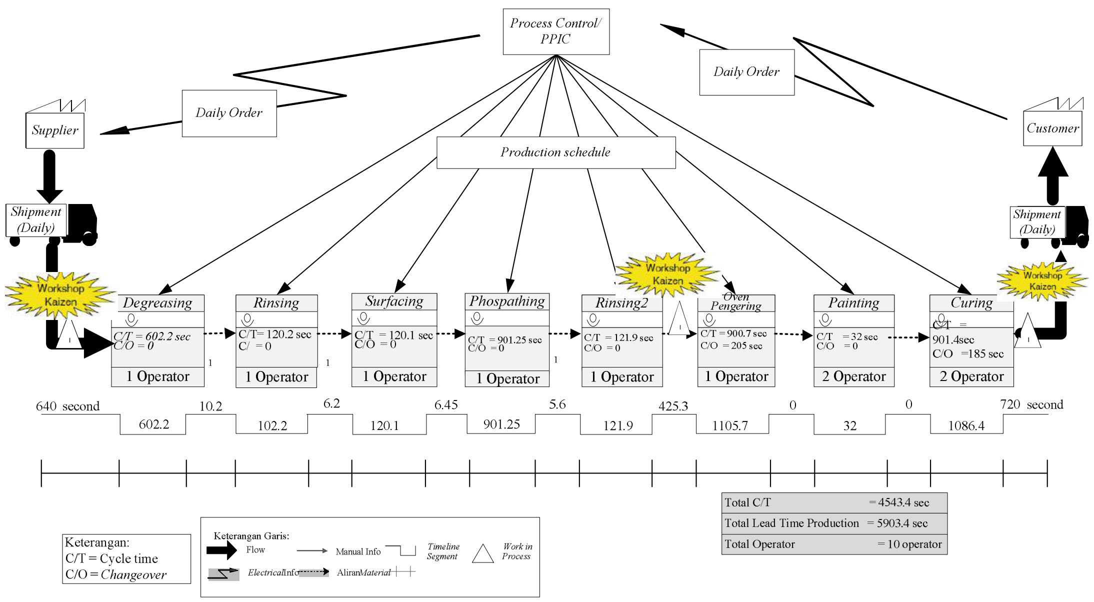

Figure 1: Current State Map Painting Process

Identify Value Added (VA) and Non Value Added (NVA)

After arranged Current State Map Painting Process, the next step is to identify Value Added (VA) and Non Value Added (NVA). Result of VA and NVA identification shown in table below.

Table 5: Added Value Dan Non Added Value Time

Process	Activity	Time (Sec)	VA	NVA	NVAN
Degreasing	Soak Drain	**602** **10.2**	√	√	
Rinsing 1	Soak Drain	**120.2** **6.2**	√	√	
Surfacing	Soak Drain	**120.1** **6.45**	√		
Phosphating	Soak Drain	**901.25** **5.6**	√	√	
Rinsing 2	Soak Drain	**121.9** **4.9**	√	√	
Oven	Brush Hanging Oven	**420.4** **205** **900.7**	√	√	√
Painting	Paint	**31.9**	√		
Curing	Oven Remove from hanger	**901.4** **185**	√		√

Total percentage of VA from the above processes is:

VA= (Total VA time)/(Total time) * 100

= 3667.75 / 4543.4

= 80.72%

Processthatidentified asNon Value Added (NVA)is draining after immersion. Total percentage of NVA is:

NVA = (Total NVA time)/(Total time) * 100%

= 485.65 / 4543.4

= 10.68%

Processthatidentified as Non Value Added but Necessary (NVAN)is the process of installing the body from the hanger and removing the body from the hanger. Total percentage of NVANis:

NVAN = (Total NVAN time)/(Total time)

= 390 / 4543.4

= 8.6%

Improvement

From interviews with the Production, Engineering and QC teams, data was obtained regarding the causes of the waste. The causes of the waste are analyzed using Root Cause Analysis, and the following data are obtained.

Table 6: Root Cause Analysis of Waste

Area	Waste	Root Cause
Oven	WIP	Improper layout, hanger is broken,
	Waiting	Lack capacity of oven
	Over processing	Rust
Degreasing	WIP	Overproduction from previous process
	Transportation	Uneven floor, cart wheel is broken
Curing	Overprocessing	Remove from hanger
	Transportation	Uneven floor, cart wheel is broken

After knowing the causes of waste, an improvement program is carried out to eliminate the waste. Methods that can be used for improvement in eliminating waste are 5W 1H. The 5W + 1H method to find out what happens (What), the source of (Where), the person in charge (Who), the time of occurrence of waste (When), the reason for happening (Why), suggestions for improvements that need to be done (How). The designed improvement programs are shown in the table below.

Table 7: Improvement Program

Waste (What)	Source (Where)	PIC (Who)	Time (When)	Reason (Why)	Improve (How)
WIP	Oven	Painting Operator	Before entrance oven	Must be brushed	Make sure that raw material are rusted free
				Improper layout	Re-layout
Waiting	Oven	Painting Operator	Before entrance oven	Hanger is broken	Change with new hanger
Over processing	Oven	Painting Operator	Before entrance oven	Brushing to proven that stove been clear	Strengthen QC *Incoming*

				from rust	
WIP	*Degreasing*	Stamping Operator	Before soaking process	Over production from previous process	Re schedule of stamping process
Transportation	*Degreasing*	Stamping Operator	Before soaking process	Uneven floor, cart wheel is broken	Repair floor and change cart wheel
Overprocessing	*Curing*	Painting Operator	After *curing*	Remove from hanger	Using automatic conveyor
Transportation	*Curing*	Assembling Operator	After *curing*	Uneven floor, cart wheel is broken	Repair floor and change cart wheel

Future State Map

After arrange improvement program related to 7 (seven) waste, next step is designing Future State Map. The above improvements are are used todesign Future State Mapping as follows:

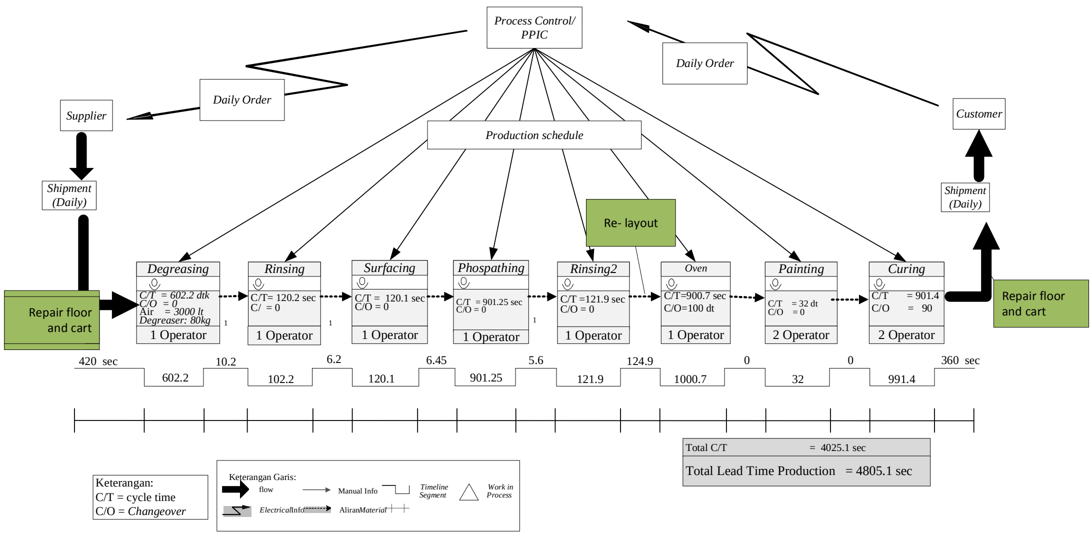

Figure 2: Future State Map Painting Process

CONCLUSIONS

Based on the analysis and discussion in this study, several processes were found, which included Added Value (VA) and Non Value Added (NVA). Totalpercentage of VA is 80.72%. The process identified as Value Added such as:

- The process of soaking in Degreasing
- The process of soaking in Rinsing 1 and 2
- The process of immersing in the Surfacing
- The process of immersing in a phosphating work station
- Oven process
- Painting process

Besidesthat, total percentage of NVA is 10.68%. Process that identified as Non Value Added (NVA)is draining

after immersion. From the Current State Mapping, found that Lead Time is 5903.4 seconds, while the results of Future State Mapping are shown that new Lead Time are 4805.1. NVA in Current State Mapping are 485.65 seconds, while in NVA is Future State Mapping are 153.35 seconds. Lead Time reduced by 1098.3 seconds, and NVA decrease by 332.3 seconds.

The factors that can affect the reduction of 7 (seven) waste in the panting process make sure that raw material are; rusted free, re-layout in painting area, change with new hanger, strengthen QC Incoming, re-schedule of stamping process, repair floor and change cart wheel, and using automatic conveyor.

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